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DETECTION OF CO EMISSION IN HYDRA I CLUSTER GALAXIES

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Abstract

A survey of bright Hydra cluster spiral galaxies for the CO(1-0) transition at 115 GHz was performed with the 15m Swedish-ESO submillimeter telescope (SEST). Five out of 15 galaxies observed have been detected in the CO(1-0) line. The largest spiral galaxy in the cluster, NGC 3312, got more CO than any spiral of the Virgo cluster. This Sa-type galaxy is optically largely distorted and disrupted on one side. It is a good candidate for ram pressure stripping while passing through the cluster's central region. A comparison with global CO properties of Virgo cluster spirals shows a relatively good agreement with the detected Hydra cluster galaxies.

Observations

Observations were performed with the 15m Swedish-ESO submillimeter telescope (SEST) at La Silla in January 1989 under favorable meteorological conditions. At a frequency of 115 GHz the half power beamwidth (HPBW) of this telescope is 43 arcsec. The cooled Schottky heterodyne receiver had a typical receiver temperature of 350 K; the system temperature was typically 650 to 900 K depending on elevation and humidity. An acousto-optic spectrometer (Zensen 1984) with a bandwidth of 500 MHz yielded a channel width of 0.69 MHz or about 1.8 km/s. In order to improve the signal-to-noise ratio of the integrated profiles usually 5 to 10 frequency channels were averaged resulting in a resolution of 9 to 18 km/s. Observations were performed in the beam switching mode with a beam separation of 12 arcmin. An integration time of 2 minutes has been selected with a chopper wheel calibration every six minutes. The pointing of the telescope has been checked every few hours on well known SIO maser sources: VY CMA and W Hya.

For elevations greater than 80° the telescope could not follow the sources correctly. This daily interruption was used for pointing checks and for obtaining comparison spectra of known galaxies like NGC 4321 and NGC 4038. A comparison with data obtained at the 30m MRT (Pico Veleta) or the 14m FCRAO telescope were satisfying.

Bright spiral galaxies of the Hydra I cluster were selected for these CO observations because of the correlation between luminosity and CO content (e.g. Young et al. 1985) in spirals and the maximum of relative CO content near morphological type Sbc and Sc (e.g. Kenney and Young 1988). The Sa type galaxy NGC 3312 was included in the search list because it is by far the largest spiral galaxy in the Hydra cluster and of its peculiar appearance being distorted on one side (e.g. Gallagher 1978).

Five out of fifteen galaxies observed have been detected in the CO(1-0) line after integration times of two to three hours (see Fig. 1). Agreement in radial velocity with optical and radio (i.e. 21cm HI) measurements is good in general as is the case for the line widths in CO and HI. (HI data were taken from the HI-catalog; Huchtmeier and Richter 1989a).

Discussion

In Fig. 2 we plot the absolute magnitude (assuming a distance of 68 Mpc for Hydra I) against the corrected (inclination) 21cm HI line width of bright Hydra spirals. These measurements fit quite well to the full line which represents the Tully-Fisher relation for the Virgo cluster (Huchtmeier and Richter 1989b). We take this as a confirmation of the adopted distance. The Virgo and the Hydra cluster are of similar type and of similar mass; the velocity dispersion of both clusters is about equal. At the adopted distance the two brightest elliptical galaxies in both clusters have about the same luminosity.

Bright spiral galaxies in the Virgo cluster have been observed to a high degree of completeness and with a good signal to noise ratio (Stark et al. 1986, Kenney and Young 1988). We will take these data as a comparison sample for our observations assuming that we should expect similar conditions in two clusters of the same type and the same size. NGC 3314B and NGC 3312 have the strongest CO fluxes in our survey. Each of these galaxies got more CO than any Virgo cluster galaxy. In NGC 3312 we observed positions 20 arcsec north and south of the centre along the major axis of this galaxy. There is some indication of emission in these two off-center positions which is not present in the positions 20 arcsec off in right ascension. In the case of NGC 3314 (Fig. 1b) we see two galaxies along the line of sight the fainter being detected. The typically good baseline behaviour is seen in the profile for NGC 3314 A (upper limit).

In Fig. 3 the luminosity and the molecular hydrogen mass of Virgo cluster galaxies (Kenney and Young 1988) is presented for three different morphological types. The lower molecular content for early type spiral galaxies is evident. For a given morphological type luminosity and gas content correlate well. The Hydra observations are plotted into this diagram (open triangles). Two Hydra galaxies are outside the range described by the Virgo sample. NGC 3312 is on the bright end side of this sample and therefore rich in molecules. As an early type galaxy (Sa to Sab) it seems really rich in molecular content compared to the Virgo cluster. From this point of view we might call it peculiar, too. NGC 3314 does not fit to the range defined by the Virgo cluster. It is too rich in molecules or too faint in luminosity or both. We noted earlier that we see two galaxies along the line of sight in this case. It is at least complicated to derive the magnitude for two superimposed galaxies. A correction of one magnitude and a half is needed to move that object up to the expected luminosity.

In Fig. 4 we compare the HI mass and the H_2 mass for the Virgo sample and our Hydra sample. The range occupied by the Virgo sample defines a good correlation. The Hydra galaxies fit quite well into the Virgo range. NGC 3312 could be a bit HI deficient for its H_2 mass. NGC 3314 is within the range defined by the Virgo galaxies.

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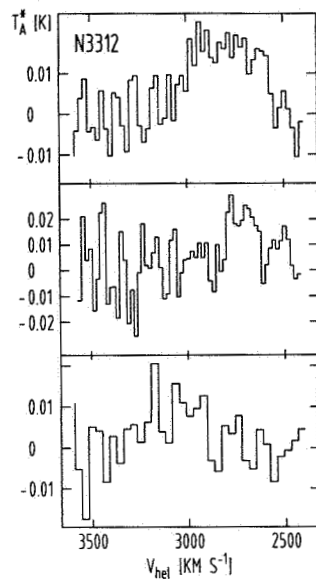


Fig.1 CO(1-0) profiles of Hydra cluster spiral galaxies.
a: NGC 3312 , center and two offset positions
b: NGC 3314 , A and B ; two galaxies along the line of sight

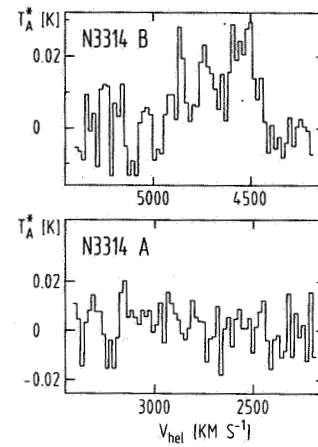


Fig. 2 Tully-Fisher relation of Hydra cluster spirals (full circles) and the Virgo cluster (full line).

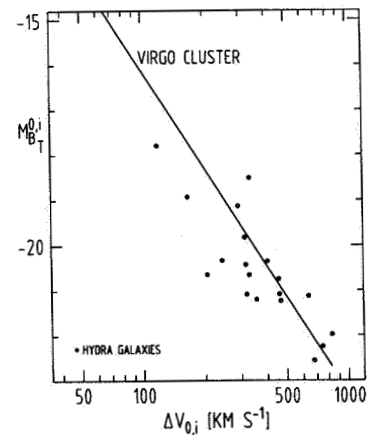


Fig. 3 Blue luminosity against molecular gas content (H_2) for the Virgo cluster and Hydra cluster galaxies (open triangles).

Fig. 4 Mass of neutral hydrogen against molecular gas content (H_2) for the Virgo cluster and Hydra cluster galaxies (open squares).

